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Real-Time Weather Observations from Within the Grand Canyon Now Available On the Web - NWS Flagstaff Installs APRS Weather Stations in the Grand Canyon: one at Indian Gardens and one at Phantom Ranch

Update: July 10, 2011: Project has been extended and real-time weather station data will remain available online through at least July 2012

Project Background:

The National Weather Service in Flagstaff recently installed two portable real-time weather stations in the Grand Canyon – one at Indian Gardens and one at Phantom Ranch. Previously, only daily maximum and minimum temperature data were available from these two locations via the NWS Cooperative Observation stations there; however this information was usually delayed by up to 12 hours. With the new stations, weather observations that include temperature, humidity, wind speed, wind direction, rainfall, and pressure data are available in near-real-time on the web with a 5 to 15 minute update frequency.

These data were made available beginning on December 2, 2010. The project was originally set to end on May 30, 2011. However, given the high demand for this project and associated weather data to remain available to researchers and the park visitors and staff, the project has been extended for at least another year, and the real-time weather data will now remain available online through at least July 2012.

The data will be primarily used for a collaborative Grand Canyon Microclimate study involving the NWS Flagstaff and Kate McLaughlin, who is an NWS Flagstaff student volunteer and physics graduate student at Northern Arizona University. Although these data will be mainly used for research purposes, it can also be accessed by anyone with web access and who would find it useful, such as people working in the canyon, hikers, or maybe even the helicopter pilots who fly down to those locations.

Although the NWS Flagstaff has long recognized and understood the difference between rim-level and inner-canyon temperatures, data regarding the diurnal trends and differences inside the canyon have not been well observed and reported in the past. As such, one of the goals of this project is to develop an understanding of microclimate of the canyon to serve as an aid to the NWS Flagstaff forecasters who routinely predict temperature and humidity inside the Grand Canyon. Each year, over 250 rescues occur from the Grand Canyon hiking trails, many of which are the result of weather or heat related injuries. With this new information, the NWS Flagstaff hopes to better inform those working or venturing into the Grand Canyon about temperature and humidity trends.

The Weather Stations:

After the late June 2010 Schultz wildfire northeast of Flagstaff, NWS Flagstaff sought to build several portable, remote, self-sustaining, and real-time weather stations to be deployed in the burn area. The purpose of these weather stations was to provide NWS Flagstaff forecasters with near-real-time rainfall data in the burn area given the potential for flooding and debris flows in and downstream of that area during the monsoon season.

Two portable weather stations were designed and built by NWS Flagstaff Electronic Technicians Eric Aselin and Steve Duiame, and NWS Flagstaff Science and Operations Officer Nick Petro. The design utilized cost-savings off-the-shelf parts, including home or business-grade weather instrument data collection packages, and hardware (tripods, masts, batteries, solar panels, equipment enclosures, and weather stations) acquired through local retailers or web-based vendors. To relay the data back to the NWS Flagstaff in near-real-time, Nick Petro (amateur radio call sign WX3H) offered his knowledge and experience as an amateur radio enthusiast to incorporate the use of the amateur radio Automatic Packet Reporting System (APSR; http://www.aprs.org) in the overall weather station design. This equipment included a VHF amateur radio, radio modem, and antenna to transmit the weather data packets to a remote receiving station which subsequently transfers the data to the internet to be viewed by NWS Forecasters and the general public. Using this design, Nick, Eric and Steve were able to successfully build and deploy two portable weather stations in the Schultz burn area during the 2010 North American Monsoon season, and these stations successfully provided near-real-time rainfall information during several high-impact flood events.

Left: NWS Flagstaff's Eric Aselin and Steve Duiame, and US Forest Service's Dick Fleishman installing the first of two portable weather stations in the Schultz burn area. Right: NWS Flagstaff's second portable weather station positioned on the north end of the Schultz burn area. Photos by Nick Petro.

At the conclusion of the 2010 monsoon season, NWS Flagstaff personnel retrieved the two weather stations from the burn area and began preparing the stations for redeployment in another mission or project. The idea of a Grand Canyon microclimate study was discussed and

developed, and Nick subsequently gained approval and research permitting from Grand Canyon officials to deploy the two weather stations in the Grand Canyon at Indian Gardens and Phantom Ranch.

On November 23, 2010, the National Park Service transported the weather stations to Indian Gardens and Phantom Ranch via helicopter, and on Thursday, December 2, 2010, NWS Flagstaff's Eric Aselin and Nick Petro hiked down into the Grand Canyon along the Bright Angel Trail to set up the stations. It was an exciting first-time hike down to the bottom of the Grand Canyon for both Eric and Nick, and fortunately the weather was perfect during the two day trip. Eric and Nick accomplished their mission of reaching Indian Gardens and Phantom Ranch and installing both stations by the end of daylight Thursday. The stations were turned on and immediately began transmitting weather information packets (using Nick's amateur radio call sign WX3H) every 5 minutes. These radio packets were intercepted by a receiving station (KL1SF) on the Grand Canyon south rim and subsequently transferred to the internet to be displayed on various weather observation web sites. After the successful installation, Nick and Eric spent the next day hiking back out of the Grand Canyon.

Steve Duiame and Eric Aselin preparing weather station for transport by helicopter down into the Grand Canyon. Photo by Nick Petro

Beginning the hike down into the Grand Canyon along the Bright Angel Trail. Elevation near the trailhead 6860 feet. Photo by Nick Petro

Eric Aselin setting up the first of two APRS weather stations in the Grand Canyon. This one is being installed at Indian Gardens. Elevation 3800 feet. Photo by Nick Petro

NWS Flagstaff's Eric Aselin and Nick Petro posing in front of their successfully installed weather station at Indian Gardens. Photo by Erika Andersson, Grand Canyon Ranger.

NWS Flagstaff SOO Nick Petro at the bottom of the Grand Canyon along the Colorado River. Photo by Eric Aselin.

NWS Flagstaff Electronic Technician Eric Aselin preparing to cross the Colorado River via the Silver Bridge to reach Phantom Ranch on the north side of the river. Photo by Nick Petro.

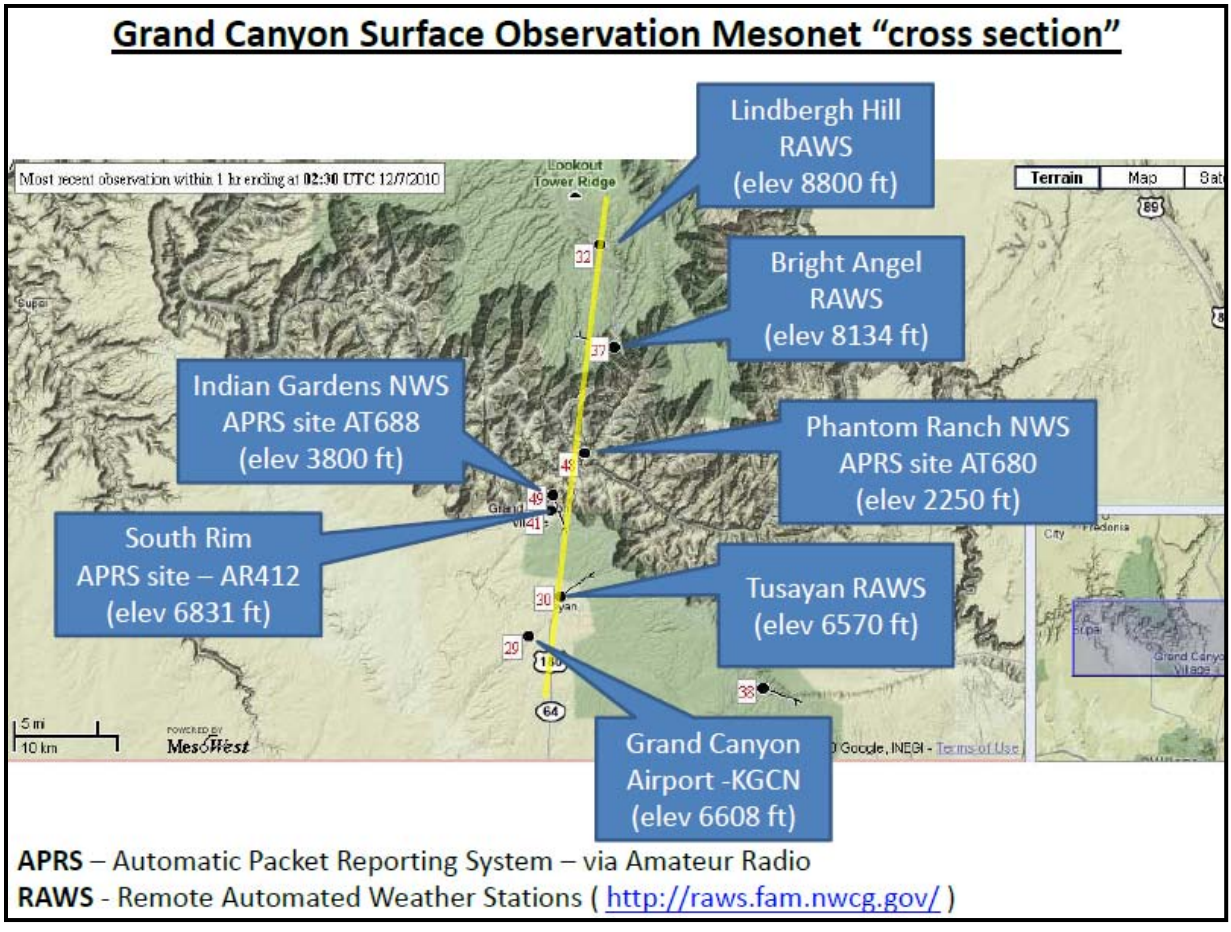
Left: Looking back up at the South Rim 4300 feet above us (looking up toward Yavapai Point) from Phantom Ranch. Photo by Nick Petro.
Right: The second of two APRS weather stations installed at the Grand Canyon. This one is installed behind the rangers' station at Phantom Ranch, near the bottom of the canyon. Elevation 2550 feet. Photo by Nick Petro.

The Data:

The data are transmitted via amateur radio APRS packets, and subsequently transferred to the Internet. The APRS data stream is picked up by several weather web sites, including the University of Utah's MesoWest (http://mesowest.utah.edu/index.html) and the National Oceanic and Atmospheric Administration (NOAA) Oceanic and Atmospheric Research's (OAR) Meteorological Assimilation Data Ingest System (MADIS; http://madis.noaa.gov). The observations are also displayed on the NWS Flagstaff's Grand Canyon forecast page. In summary, the data can be viewed via the following sites:

- **Indian Gardens** – located along the Bright Angel Trail at 3800 feet elevation (3060 feet below the 6860-foot elevation trailhead on the south rim), and 4.6 miles down the trail: http://www.wrh.noaa.gov/mesowest/getobext.php?sid=AT688&table=1
- **Phantom Ranch** – located along and just north of Colorado River at 2550 feet elevation (4310 feet below the 6860-foot elevation trailhead on the south rim), and accessed via the Bright Angel Trail 10 miles from the south rim trailhead: http://www.wrh.noaa.gov/mesowest/getobext.php?sid=AT680&table=1
- **NWS Flagstaff Grand Canyon Forecast page –** for an overview of Grand Canyon conditions and forecast information: http://www.wrh.noaa.gov/fgz/Rec_Forecast/rec_forecast.php?wfo=fgz

The data nicely fit in a north-south cross section of the Grand Canyon through 7 weather stations (two of which include the new ones). The graphic below demonstrates this *Grand Canyon mesonet*, which shows these stations lined up across the canyon and at a variety of elevations.



Aknowledgements:

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- Joe Lachacz, Electronic Program Manager, NWS Western Region Headquarters, for providing equipment and support for the portable weather stations.
- NWS Hanford, CA – Guide to setting up a remote weather station - http://www.wxqa.com/aprs_setup_guide.pdf
- US National Park Service, including Lisa Hendy, U.S. Park Ranger Supervisor, Ronda Newton, GCNP Research Permitting Coordinator, and Shannon Reed, GCNP Air Quality Specialist.
- Sean Fielding, KL1SF, Grand Canyon Communications Center Manager, for providing an APRS receiving station and internet gateway at his residence on the south rim. This volunteer resource allows NWS Flagstaff's Grand Canyon weather station packets to be received and transferred to the internet.

For more information:

If you have any questions about this project, please contact:

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